TECHNICAL SPECIFICATIONS FOR CROSS LINKED POLYETHYLENE INSULATED 3 CORE 11KV CABLES

1.00.00 **SCOPE:**

1.01.00 The scope of this package, covers the design, manufacture, stage inspection at works, inspection and testing of finished cables at manufacture's works, testing at independent test house, packing, transport and delivery to consignee's address of 6.35/11KV Three Core, aluminium conductor, XLPE insulated, screened, under ground Cables as per specified construction.

1.02.00 Technical Requirement: Three Core 6.35/11KV grade, 90^0C rating heavy duty power cable with stranded compacted circular aluminium conductor shielded with extruded semi conducting compound, cross linked polyethylene insulated, shielded with extruded semi conducting compound and copper tape, shielded cores laid up with fillers, inner sheath of extruded PVC, Galvanized round steel wire Armour and PVC ST-2 overall sheath.

1.03.00 The cables should be suitable for use in solidly earthed system.

1.04.00 The Stranded Aluminium Conductor for different sizes of cable shall have the short circuit rating specified in this document, in schedule of requirement, schedule-I, Annexure TS-1.

2.00.00 **STANDARDS:**

2.01.00 The 11KV UG Cables shall, in general, meet the requirements of the latest edition of the Bureau of Indian Standards, (generally referred as IS) IS 7098 (Part-2) 1985. The cables manufactured to and meeting the testing requirements of international standards, like B.S.S. IEC or equivalent standards are also acceptable. The bidders shall enclose a copy of the equivalent international standard, in English Language, along with the Bid.

The extracts from IS 7098 (Part 2) are given in Annexure TS-3.

The cables and components in general shall meet the requirement Indian Standards with latest amendments or equivalent International Standards.

IS: 7098 (Part 2)	1985 :	Specification for cross linked polyethylene insulated PVC sheathed cables
IS: 8130	1984 :	Specification for conductors for insulated

		Electric Cables
IS: 3975	1979 :	Specification for mild steel wires, strips and tapes for armouring of cables.
IS: 10810 (Part 1 to 55)	1984 :	Specification for test on cables
IS: 5831	1984 :	Specification for PVC insulation and sheath of electric cables
IS: 10418	1982 :	Specification for drums for electric cables
IS: 10462 (Part-I)	1983 :	Fictitious calculation method for determination of dimensions of protective covering of cables: Part-I Elastomeric and thermoplastic insulated cables.

2.02.00 11KV underground cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The Bidder shall furnish the quality plan, giving in details the quality control procedures/management system.

The successful bidder shall give sufficient advance notice to the purchaser of not less than fifteen days to arrange for stage inspection and inspection of quality assurance programme during manufacture, at the works.

3.00.00 **SYSTEMS DETAILS:**

General Technical Particulars:

1) Nominal System Voltage (rms) (u) - 11 KV
2) Highest System Voltage (rms) (um) - 12 KV
3) Phase to Earth Voltage (uo) - 6.35 KV
4) Number of Phases (for 3 core cables) - 3
5) Frequency - 50 Hz
6) Variation in frequency - ±3%
7) Type of Earthing - Solidly Earthed
8) Basic impulse level (1.2/50 Micro Second Wave - 75 KV
9) Total relay & circuit break operating time - 15-20 Cycles
10) One minute power frequency withstand voltage- 28 KV

4.00.00 **INSTALLATION CONDITIONS**:

a) Mostly directly buried in ground, partly in RCC/Hume pipes or stoneware pipes at road crossing in case of 3 core cables.

b) If more than one circuit is laid in the same trench, then laid in flat formation for 3 core cables.

c) Metallic coverings are connected solidly to earth at both ends of the run for 3 core cables and.

d) Normal depth of laying is 900 mm to 1000 mm (from top of round to entre of cable).

e) Nature of soil – Heterogeneous, sandy.

f) Soil resistivity: variable 18 to 100 Ohm – meter

g) Soil Thermal resistivity (assumed) 120 to 150 dig. C. Cm/w.

5.00.00 **CLIMATIC CONDITIONS**:

The climatic conditions at Bangalore City where these 11KV Cables will be installed are as under:

1	Location	Karnataka (28.58 N, 77.38E)
2	Altitude	1000 M above MSL
3	Max. ambient air temperature	45^0 C
4	Max. daily average air temp.	38^0 C
5	Minimum ambient air temp.	10^0 C
6	Ground temperature at depth of laying assumed	35^0 C (Max.)
7	Isoceranic level	5^0 C (Min.)
8	Avg. annual rainfall	As per IS:45
9	Avg. number of rainy	1450 Sq.mm.
10	Climate	Tropical Moderately hot and humid
11	Soil	Normally dry. As per IS:1200 Part-I, 1974, likely hood of subsoil water at certain location at depth of burial of cables.

6.00.00 **DESIGN CRITERIA**:

6.01.00 The cables that are covered in these specifications are intended for use in the Karnataka Power distribution system, under the climatic conditions and installation conditions descried in the technical specification.

6.02.00 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only in the offer made by the Bidder, giving technical reasons, and justifying the need to incorporate these features.

6.03.00 For continuous operation of the cables, at specified drawing, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90^0C under normal operation and 250^0C under short-circuit conditions.

6.04.00 The cables in service will be subject to daily load cycles, of two peaks during day, morning peak and evening peak with reduced loading during the nights.

6.05.00 The materials used for sheaths shall be resistant to oils, acids and alkalies.

6.06.00 The cables shall be designed to withstand the thermo mechanical forces and electrical stresses during normal operation and transient conditions.

The Cables shall be designed to have a minimum useful life span of forty years.

Core identification: The core identification for 3 core cables shall be provided, by suitable means, like, by application of coloured stripes, or by numerals or by printing on the cores as per clause 13 of IS:7093.

7.00.00 **MANUFACTURE PROCESS, CROSS LINKING OF INSULATION:**

7.01.00 Cross linking of the insulation materials (pre compounded polyethylene) shall be conforming to IS:7098 (Part-II).

7.02.00 The conductor screen shall be of extruded semi conducting compound. The insulation screen shall consist of the nonmetallic part extruded semi conducting compound with non magnetic metallic port. The XLPE insulation and the shields for conductor and insulation shall be extended in one operation.

8.00.00 **MATERIALS:**

8.01.00 CONDUCTOR: The conductor shall be of stranded construction. The material for conductor shall consist of plain aluminium of H2 or H4 grade as per clause-3 of IS:8130/1984.

The number of wires in the conductor shall be not less than the appropriate minimum number given in Table-2 of IS:8130/1984.

8.02.00 INSULATION: The insulation shall be cross linked polyethylene conforming to the requirements given in Table-1 of IS:7098 Part-II.

8.03.00 SCREENING: The screening shall consist of semi conducting compound. The metallic screen for core shall consist of copper tape. The metallic screen with Armour shall be designed to carry the minimum short circuit rating for 1 second. (The design calculations shall be furnished by the tenderer).

8.03.01 The semi-conducting compound shall withstand the operating temperature of the cable and shall be compatible with the insulting materials.

8.04.00 **Filler and inner sheath for Multi Core Cables:**

For Multi Core cables, the interstices at the centre shall be filled with a non-hygroscopic materials.
The interstices around the laid up cores shall be covered with PVC compound type S.T-2. This will form the inner sheath for Multi Cores Cables.

8.05.00 **ARMOURING FOR 3 CORE CABLES:**

The armour shall be galvanized round steel wire, complying with the requirements of IS:3975. The Single Core Cables shall be armoured with hard drawing Aluminium round wire. A binder tape may be applied on the armour.

8.06.00 **OUTER SHEATH**:

The outer sheath shall consist of Poly Vinyl Chloride (PVC) compound, confirming to the requirements of Type ST-2 of IS:5831 suitable additive shall be added to give anti termite protection.

9.00.00 **CONSTRUCTION:**

The general constructional features of the cables shall be as follows:

a) **3 Core Cables**: Stranded, Compacted, Circular, Aluminium Conductor, Conductor Screen of extruded semi conducting compound, Cross linked polyethylene insulation, shall be conforming to IS:7098 (Part-II).

Insulation screen consisting of non-metallic part of extruded semi conducting compound and the metallic part of copper tape(s).

Pressure Extruded PVC inner sheath
Armour (Galvanised Steel round wire)
Other PVC sheath with anti-termite treatment.

10.00.00 **CONDUCTOR:**

10.01.01 The conductor shall be stranded, compact, circular of aluminium wires of H2 or H4 grade plain aluminium wires.

10.01.02 The conductor shall be clean, uniform in size and shape smooth and free from harmful defects.

10.01.03 Not more than two joints shall be allowed in any one of the single wire forming every complete length of conductor and no joint shall be within 300 mm of any other joint in the same layer. The joint shall be made by brazing, silver soldering or electric or gas welding.

10.01.04 No joints shall be made in the conductor after it has been stranded.

10.02.00 **CONDUCTOR SCREEN**: The conductor screen shall be provided over the conductor consisting of extruded non metallic semi conducting compound.

10.03.00 **INSULATION**: The insulation shall be provided over the screened conductor with cross linked polyethylene, applied by extrusion and shall be of high quality, cross linked, shall be conforming to IS:7098 (part-2).

10.03.01 **THICKNESS OF INSULATION**: The average thickness of XLPE insulation shall not be less than the nominal value subject to the applicable tolerance as specified in table 2 of IS: 7098.

10.03.02 The insulation shall be applied to closely fit on the conductor screen, and it shall be possible to remove it without damaging the conductor.

10.03.03 The thickness of semi conducting screen over insulation should not be included in the thickness of Insulation.

10.04.00 **INSULATION SCREENING:** The Insulation screen shall be applied over the Insulations.

10.04.01 The Non-Metallic part of the Insulation screen shall consist of extruded Semi conducting compound.

10.04.02 The metallic part of the insulation screen shall consist of non-magnetic material, consisting of copper tape or tapes, and shall be applied over the non-metallic part. The metallic tape(s) shall be designed to carry the rated short circuit current.

10.05.00 **LAYING UP OF CORES:** For multi-core cables, the cores shall be laid together with a suitable right hand lay. The interstices at the centre shall be filled with a non-hygroscopic material.

10.06.00 **INNER-SHEATH FOR MULTI CORE CABLES:**

10.06.01 The cores shall be laid up with a suitable right hand lay and the interstices should be filled with PVC compound type ST2 conforming to IS:5831 or equivalent standard. The filling up of interstices shall

be by pressure extrusion and this circular shape and shall bind the cores also.

10.06.02 The minimum thickness of the inner sheath shall conform to Table 3 of IS: 7098 (Part-2), 1985 or equivalent standard.

10.06.03 The inner-sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation cables.

10.07.00 **ARMOURING FOR 3 CORE CABLES:**

10.07.01 **Application**: The armour consisting of Galvanised steel wire shall be applied over the inner sheath for multi core cables.

10.07.02 The armour wires shall be applied as closely as possible.

10.07.03 The diameter of the galvanised round steel and hard drawn aluminium wires shall conform to IS: 7098 Part (2).

10.07.04 A binder tape may be applied on the armour.

10.07.05 The Joints in the armour wires shall be brazed/welded with joint surface and rendered smooth. The joints shall be staggered by at least 300 mm from the nearest joint in any other armour wire in the completed cable.

10.08.00 **OUTER SHEATH:**

10.08.01 The PVC outer sheath with anti termite treatment shall be extruded over the armouring for 3 core cables.

10.08.02 The colour of the outer sheath shall be black.

10.08.03 The thickness of outer sheath shall be not less than the minimum value specified in column 5 of Table 5 of IS: 7098 (Part-2) 1985.

10.09.00 **IDENTIFICATION:** The outer-sheath shall have the following information embossed or indented on it, the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters "BESCOM". The identification shall repeat every 300/350 mm along with length of the cable.

11.00.00 **INSPECTION**:

11.01.00 Quality Control: The Bidder shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement.

During the manufacturing process, at all stages, inspections shall be made to check the physical and dimensional parameters, for verification to compliance to the standards.

11.02.00 The Bidder shall arrange, for inspection by the purchaser, during manufacture, if so desired by the purchaser, to verify the quality control process of the Bidder.

12.00.00 **TYPE TESTS**:

Not withstanding, that type test have been conducted earlier, the successful bidder the each member of consortium shall conduct all type tests as per IS:7098 part (2), 1985 with upto date amendments or equivalent international standard at his cost at either CPRI or any other accredited national laboratory/testing house and materials offered for inspection. Only after approval of the test reports from the purchaser materials shall be offered for inspection.

12.01.00 All type tests, routine, acceptance test shall be conducted in the presence of the purchaser, representative.

12.02.00 The successful Bidder shall give 15 days advance notice for inspections, and witnessing of tests by the purchaser or his representative.

12.03.01 The following type tests will be conducted on the cable.

a) Test on conductor
b) Test on armour wires
c) Test for thickness of XLPE insulation and inner and outer sheaths
d) Physical test on XLPE insulation
e) Physical test for outer sheath
f) Partial discharge test
g) Bending test
h) Di-electric power factor test
    (i) As a function of voltage
    (ii) As a function of temperature
i) Insulation resistance (Volume resistivity) test
j) Heating cycle test
k) Impulse withstand test
l) High voltage test
m) Flammability test

12.03.02 The following test shall be performed successively on the same test sample of completed cable, not less than 10 M in length between the test accessories.

a) Partial discharge test
b) Bending test followed by partial discharge test
c) Dielectric power factor as a function of voltage
d) Dielectric power factor as a function of temperature
e) Heating Cycle test, followed by dielectric power factor and function of voltage and partial discharge test.

f) Impulse withstand test
g) High voltage test.

12.04.00 **ACCEPTANCE TEST**:

12.04.01 The sampling plan for acceptance test shall be as per IS:7098 Part (2) 1985, Appendix 'A'.

12.04.02 The following shall constitute the acceptance test.

a) Tensile test for aluminium
b) Wrapping test for aluminium
c) Conductor resistance test
d) Test for thickness of insulation
e) Test for thickness of inner and outer sheath
f) Hot-set test for insulation
g) Tensile strength and elongation at break test for insulation and outer sheath
h) Partial discharge test (on full drum length)
i) High voltage test
j) Insulation resistance (volume resistivity) test.

12.05.00 **ROUTINE TEST**:

The following shall constitute routine tests:

a) Conductor resistance test
b) Partial discharge test on full drum length
c) High voltage test

13.00.00 **PACKING**:

13.01.01 The cables, as per specified delivery lengths, shall be securely wound/packed in non-returnable, well seasoned sturdy wooden drums, with strong reinforcements so as to withstand rough handling during transport by Rail, Road etc., The packing should withstand storage conditions in open yards. The cable drums shall conform to IS:10418-1982 or equivalent standard.

13.01.02 The drawing of cable drums with full detail shall be furnished, and got approved before dispatch.

13.02.00 **SEALING OF CABLE ENDS ON DRUMS**:

13.02.01 The Cable ends shall be sealed properly so that ingress of moisture is completely prevented.

13.02.02 The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a heat

shrinkable cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

13.02.03 The three cores should have a over all heat shrinkable cap with adequate end clearance, and sufficient cushioning to prevent puncturing of the overall sealing cap due to stretching of the cores. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable.

13.02.04 **CABLE LENGTHS**: The cables shall be supplied in continuous lengths of 250/500 m in case of 3 core cables with a tolerance of ± 5% of drum length.

13.02.05 **QUANTITY TOLERANCE**: ±5% tolerance shall be allowed on the ordered quantity.

14.00.00 **MARKING**:

The packed a cable drum shall carry the following information, clearly painted or stenciled.

a) The letters “BESCOM”
b) Reference to Standard and ISI Mark
c) Manufacture’s Name or trade mark
d) Type of Cable & Voltage grade
e) Number of cores
f) Nominal cores sectional area of conductor
g) Cable code
h) Length of cable on the drum
i) Direction of rotation
j) Gross weight
k) Country of Manufacture
l) Year of Manufacture
m) Purchase Order No. and Date
n) Address of consignee.

15.00.00 Cross sectional drawings of the cables giving dimensional details for each size of cable.

a) An illustrated literature on the cable giving technical information, on current ratings, cable constants, short circuit ratings, derating factors for different types of installation packing date weights and other relevant information.

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SCHEDULE-I

Annexure: TS-1

Schedule of requirement of 3 core armoured, 1 core armoured, 6.35/11KV (E) aluminium conductor, XLPE UG Cables

Sl. No.	Cross sectional area of conductor (Sq.mm.)	Minimum current rating (Amps) in ground	Minimum short circuit rating (KA/1 Sec)	Delivery length per drum (± 5%)
1	3 x 95	190	8.9	500 M
2	3 x 240	315	22.5	250 M
3	3 x 400	395	37.6	250 M

The approximate current ratings in column 3 are for the following standard installation conditions.

i)	Maximum conductor temperature for continuous operation	90 Deg. C.
ii)	Ambient air temperature	40 Deg. C.
iii)	Ground temperature	30 Deg. C.
iv)	Thermal resistivity of soil	150 Deg. C.
v)	Depth of laying	90 cm
vi)	Maximum conductor temperature at the end of short circuit	250 Deg. C.
vii)	Method of installation	Installed single directly buried in ground

SCHEDULE-II

Annexure: TS-2

For the information of Bidder the important extracts from the Indian Standard IS:7098 (Part 2) 1985; "Specification for cross linked polyethylene insulated PVC sheathed cables are furnished here for their reference and to supply for the XLPE Cables called for in the bid specification

TABLE-1:- PROPERTIES OF XLPE INSULATION

Sl. No.	Property	Requirement
1	Tensile Strength	12.5 N/Sq.mm. Min.
2	Elongation at break	200 percent, Min.
3	**Ageing in air over**: a) Treatment: Temperature Duration b) Tensile Strength Variation c) Elongation Variation	 135 ± 3 Deg. C 7 Days ± 25% Max. ± 25% Max.
4	**Hot Set**: a) Treatment: Temperature Time under load Mechanical stress b) Elongation under load c) Permanent Elongation (Set after cooling)	 200 ± 3 Deg. C 15 minutes 20 N/Sq.mm. 175% Max. 15% Max.
5	**Shrinkage**: a) Treatment: Temperature Duration b) Shrinkage	 130 ± 3 Deg. C 1 Hour 4% Max.
6	**Water absorption (gravimetric)**: a) Treatment: Temperature Duration b) Water absorbed	 85 ± 2 Deg. C 14 Days 1 Mg/Sq.mm. cm. Max.
7	**Volume resistivity**: a) At 27 Deg. C b) At 90 Deg. C	 1×10^{14} ohm-cm. Min. 1×10^{12} ohm-cm. Min.

TABLE-2:- NOMINAL THICKNESS OF INSULATION

Nominal Area of Conductor in Sq.mm.	Nominal thickness of insulation (ti) in mm. 6.35/11KV – 3 Core
95	3.6
240	3.6
400	3.6

1) Thickness of insulation: The average thickness of insulation shall not be less than the nominal value (ti) specified in Table-2.

2) Tolerance on thickness of insulation: The smallest of the measured values of thickness of insulation shall not fall below the nominal value (ti) specified in Table-2 by more than 0.1 mm + 0.1 ti.

TABLE-3:- THICKNESS OF INNER SHEATH (All dimensions in mm)

Calculated diameter over laid up cores (ref. IS 10462 Part 1, 1983) *		Thickness of inner sheath (Min.)
Over	Upto & including	
(1)	(2)	(3)
-	25	0.3
25	35	0.4
35	45	0.5
45	55	0.6
55	-	0.7

(*) Fictitious calculation method for determination, dimensions of protective coverings of cables: Part-I Electrometric and Thermoplastic Cables.

TABLE-4:- DIMENSIONS OF ARMOUR GALVANIZED STEEL ROUND WIRES AND STRIPS

NOTE: The dimensions of Galvanised steel wires or strips shall be as specified in Table-4.

Calculated diameter for Armour (ref. IS 10462 Part 1, 1983) *		Nominal thickness of steel strip	Nominal diameter of Round wire
Over	Upto & including		
1	2	3	4
a) For all diameter in excess of 13		0.8	Nil
-	13	-	1.40
13	25	0.8	1.60
25	40	0.8	2.00
40	55	1.4	2.50
55	70	1.4	3.15
70	-	1.4	4.00

Note: (a) and (b) indicate two methods of practice in the application of armouring.

* Fictitious calculation method for determination of dimensions of protective covering of cables: Part-I Electrometric & Thermoplastic Insulated Cables.

TABLE-5:- THICKNESS OF OUTER SHEATH (All dimensions in mm)

Calculated diameter under the outer sheath (ref. IS:10462 Part 1, 1983) *		Nominal thickness of steel strip		Minimum thickness of outer sheath for Armoured Cables
Over	Upto & including	Nominal (ts)	Minimum	
1	2	3	4	5
-	15	1.8	1.24	1.24
15	25	2.0	1.40	1.40
25	35	2.2	1.56	1.56
35	40	2.4	1.72	1.72
40	45	2.6	1.88	1.88
45	50	2.8	2.04	2.04
50	55	3.0	2.20	2.20
55	60	3.2	2.36	2.36
60	65	3.4	2.52	2.52
65	70	3.6	2.68	2.68
70	75	3.8	2.84	2.84
75	-	4.0	3.00	3.00

(*) Fictitious calculation method for determination of dimensions of protective covering of cables: Part-I Electrometric & Thermoplastic Insulated Cables.

Note:

Armoured Cables: The thickness of outer sheath shall be not less than the minimum value specified in column 5 of Table-5.

Extracts from IS:7098 (Part 2), 1985, on Tests on Cables:

i) Partial Discharge Test: The Partial discharge magnitude at test voltage equal to 1.5 Uo shall not exceed 20 PC.

ii) Bending Test: The diameter of test cylinder shall be (20D ±5) percent, where D is the overall diameter of the completed cable.

iii) Dielectric Power Factor Test:

a) Tan ‘delta’ as a function of voltage:

The measured value of tan ‘delta’ at Uo shall not exceed 0.004 and the increment of tan ‘delta’ between 0.5 Uo and 2 Uo shall not be more than 0.002.

b) Tan ‘delta’ as a function of temperature:

The measured value of tan ‘delta’ shall not exceed 0.004 at ambient temperature and 0.008 at 90 Deg. C.

iv) Heating Cycle (As per IS: 10810 Part 49):

After their cycle, the sample shall be subjected to dielectric power factor as a function of voltage and partial discharge test.

v) Impulse withstand test:

The impulse voltage level for cables of rated voltage 6.35/11KV is 75 KV. No breakdown of insulation shall occur during the test.

vi) High voltage test (As a type test/Acceptance test) for 6.35/11KV rated voltage cables:

The cable shall withstand without breakdown an A.C. Voltage equal to 3 Uo but not less than 17 KV (rms when applied to the sample between conductor and screen/metallic tape/armour, the voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

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